

Responses of ecosystem productivity to precipitation addition at Stubai grassland site simulated by land surface models

Yongwen Liu and all INTERFACE altered rainfall modelers

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1 Background (INTERFACE)

- **Predicted precipitation changes due to climate change**

Increases and decreases in precipitation amounts

Increases in extreme precipitation event

(IPCC, 2013)

- **Asymmetric response of ANPP to altered precipitation**

Pulses in ANPP with
increased precipitation

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Reductions in ANPP with
precipitation declines

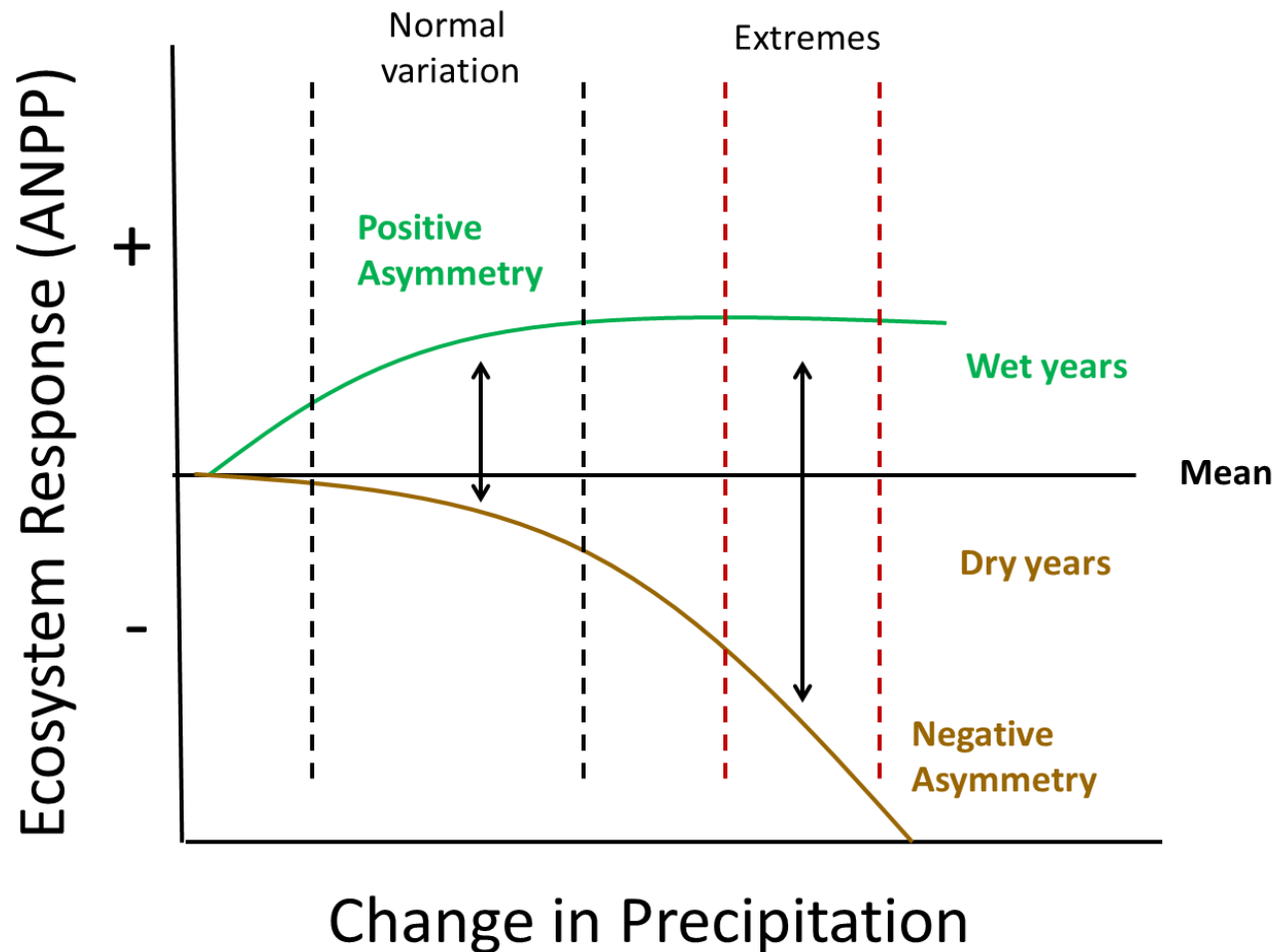
Pulses in ANPP with
extreme wet periods

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Reductions in ANPP with
droughts

Nicolas Viovy, Philippe Ciais, and Jakob Zscheischler et al. The effects of altered precipitation on ecosystem productivity analyzed by combining ecosystem global change experiments and model results. Version 1.1. 2015/5/22.

Conceptual model of asymmetric ecosystem response



Nicolas Viovy, Philippe Ciais, and Jakob Zscheischler et al. The effects of altered precipitation on ecosystem productivity analyzed by combining ecosystem global change experiments and model results. Version 1.1. 2015/5/22.

Question

Is there asymmetric response of aboveground NPP to altered precipitation across ecosystems?

Nicolas Viovy, Philippe Ciais, and Jakob Zscheischler et al. The effects of altered precipitation on ecosystem productivity analyzed by combining ecosystem global change experiments and model results. Version 1.1. 2015/5/22.

Methods

Create forcing datasets for models

Create altered (artificial) precipitation forcing climate input data across 10 different regimes.

Alter precipitation decreasing/increasing each precipitation event by -75%, -50%, -25%, 0, +25%, +50%, +75%, +100%, +150%, and +200%.

Run models with protocol

CLM, LPJ, ORCHIDEE, OCN, JSBACH, JULES and other TRENDY models perform the runs..

All modelers perform test runs at the first site: Stubai grassland site.

Analyze simulations of test run

Get the quick plots of the Stubai site test run to discuss the possible issues and modification of protocol.

Nicolas Viovy, Philippe Ciais, and Jakob Zscheischler et al. The effects of altered precipitation on ecosystem productivity analyzed by combining ecosystem global change experiments and model results. Version 1.1. 2015/5/22.

Test run at the first site (Stubai)

Brief information of Stubai grassland site

Country	Australia
Grassland Type	Meadow
Altitude	1850 m
Annual mean air temperature	3°C
Annual precipitation	1097 mm
Land management	Organic fertilization One cut, grazed in late summer
Spring aboveground biomass	190-313 g/m ²
Summer aboveground biomass	244-440 g/m ²
Autum aboveground biomass	224-261 g/m ²

Schmitt, M., Bahn, M., Wohlfahrt, G., Tappeiner, U., and Cernusca, A.: Land use affects the net ecosystem CO₂ exchange and its components in mountain grasslands, Biogeosciences, 7, 2297-2309, 10.5194/bg-7-2297-2010, 2010.

Available simulations of Stubai « test run »

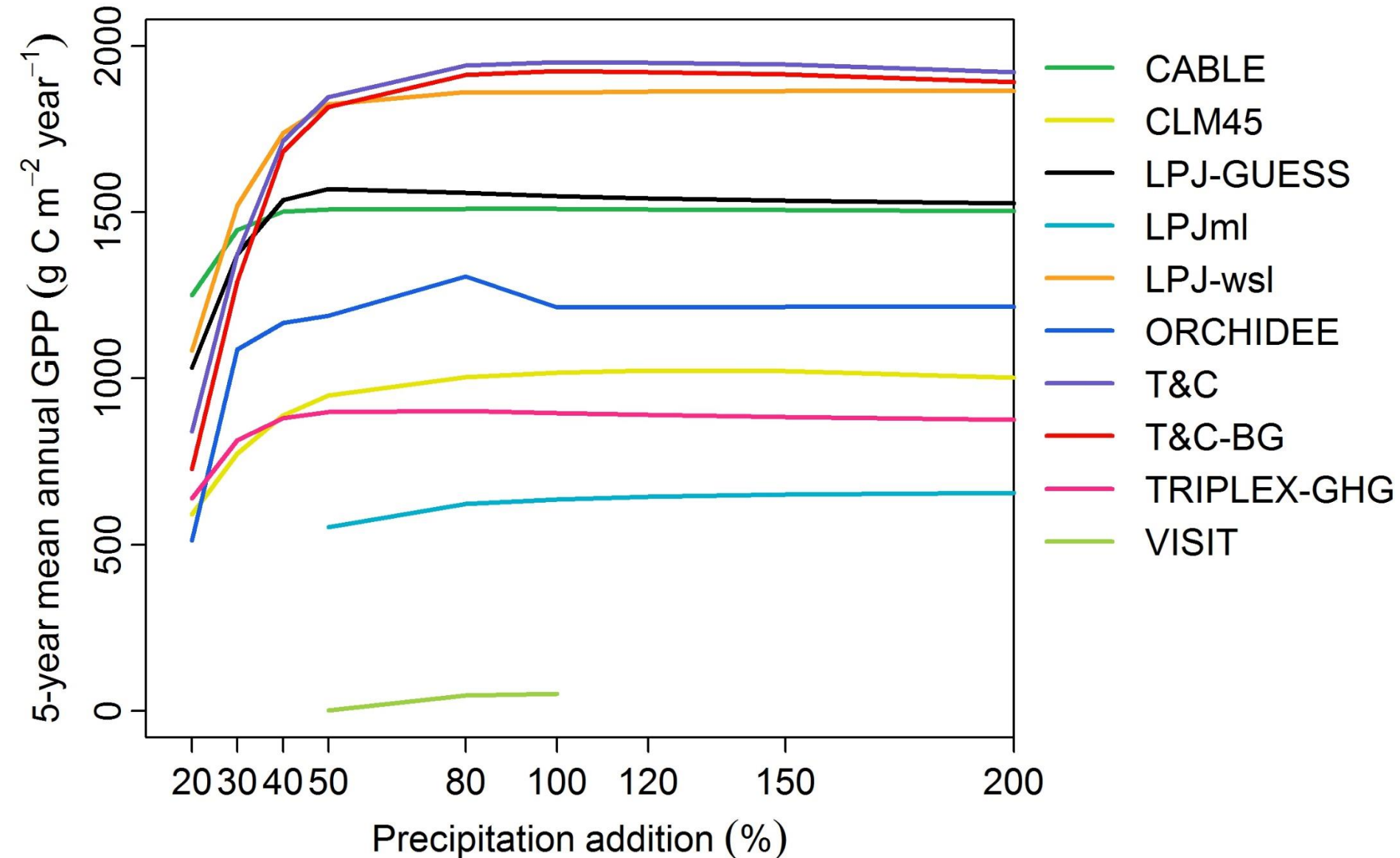
Models	GPP	NPP	NPP above	Soil moisture	LAI	Snow depth	Albedo
CABLE	Hourly	Hourly	-	Hourly	Hourly	-	-
CLM45	Daily	Daily	Daily	Daily	Daily	-	-
LPJ-GUESS	Annually	Annually	-	-	Annually	-	-
LPJml	Daily	Daily	-	Daily	Daily	Monthly	Monthly
LPJ-wsl	Monthly	Monthly	-	Monthly	-	Monthly	-
ORCHIDEE	Daily	Daily	-	Daily	Daily	-	-
T&C	Daily	Daily	Daily	Hourly	Daily	-	-
T&C-BG	Daily	Daily	Daily	Hourly	Daily	-	-
TRIPLEX-GHG	Daily	Daily	Daily	Daily	Daily	-	-
VISIT	Daily	Daily	Daily	Daily	Daily	-	-

Precipitation addition: 20%, 30%, 40%, 50%, 80%, 100%, 120%, 150%, and 200%.

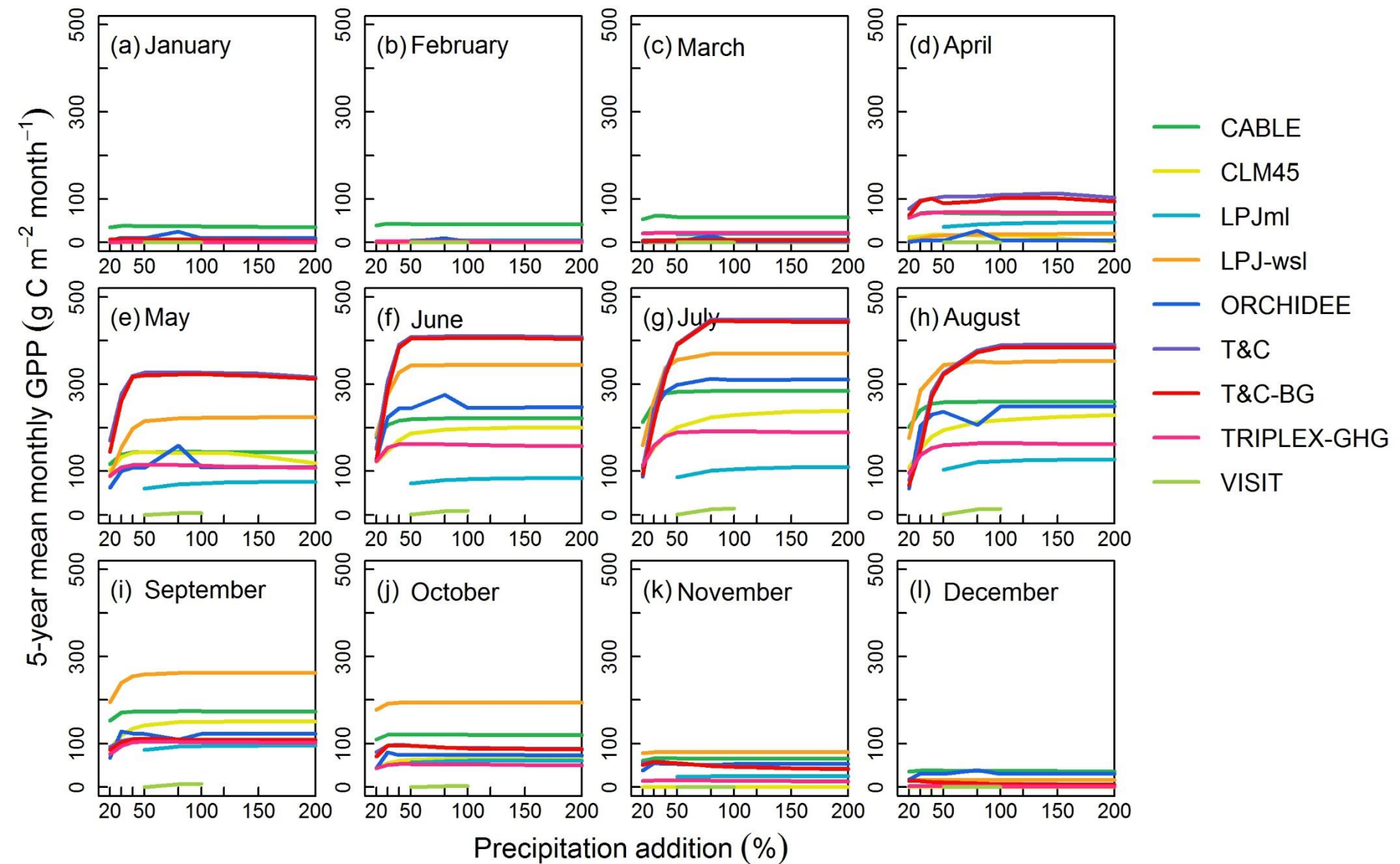
Not every model simulated all levels of precipitation addition.

3 Quick plots of Stubai « test run »

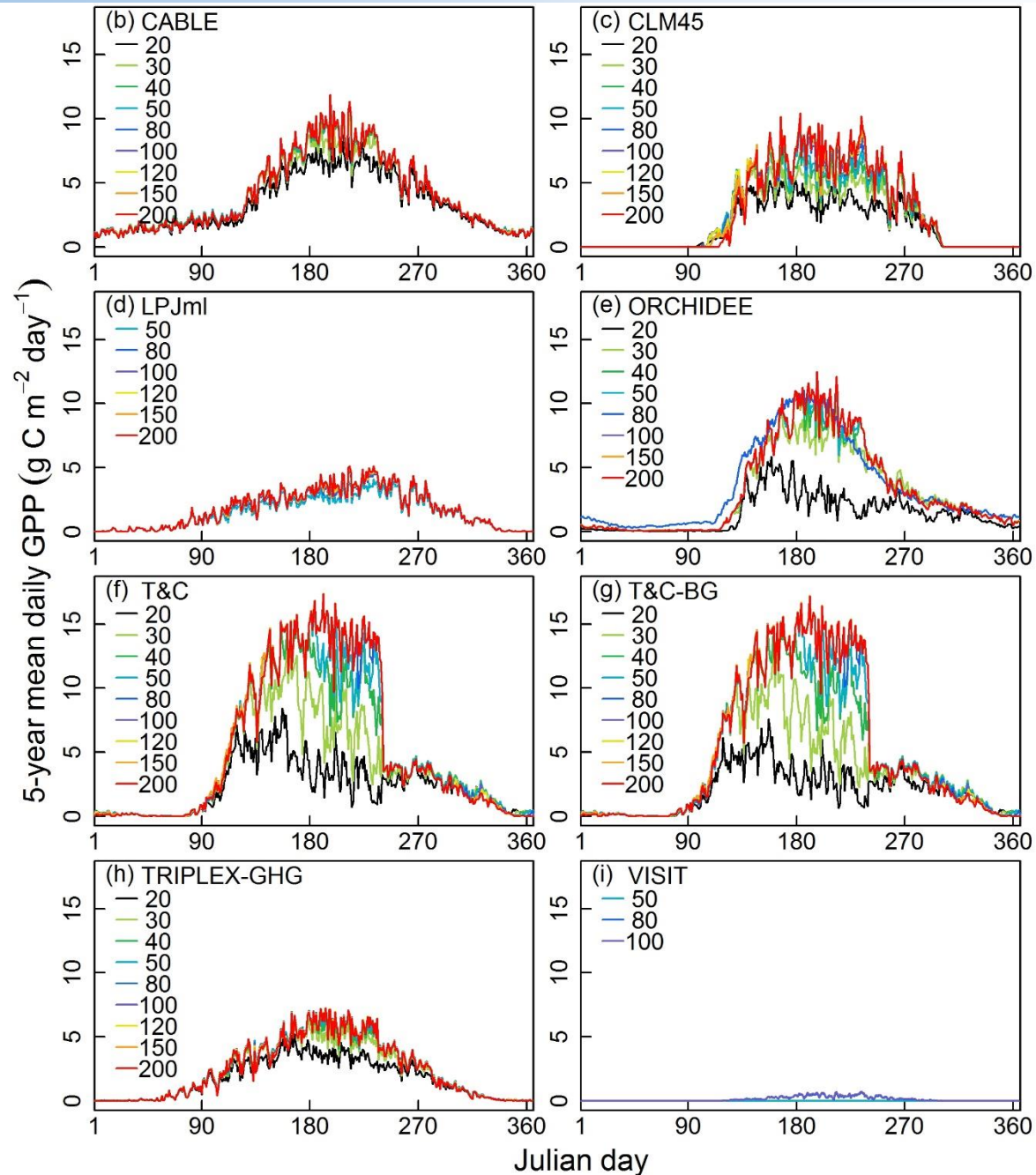
5-year mean annual GPP



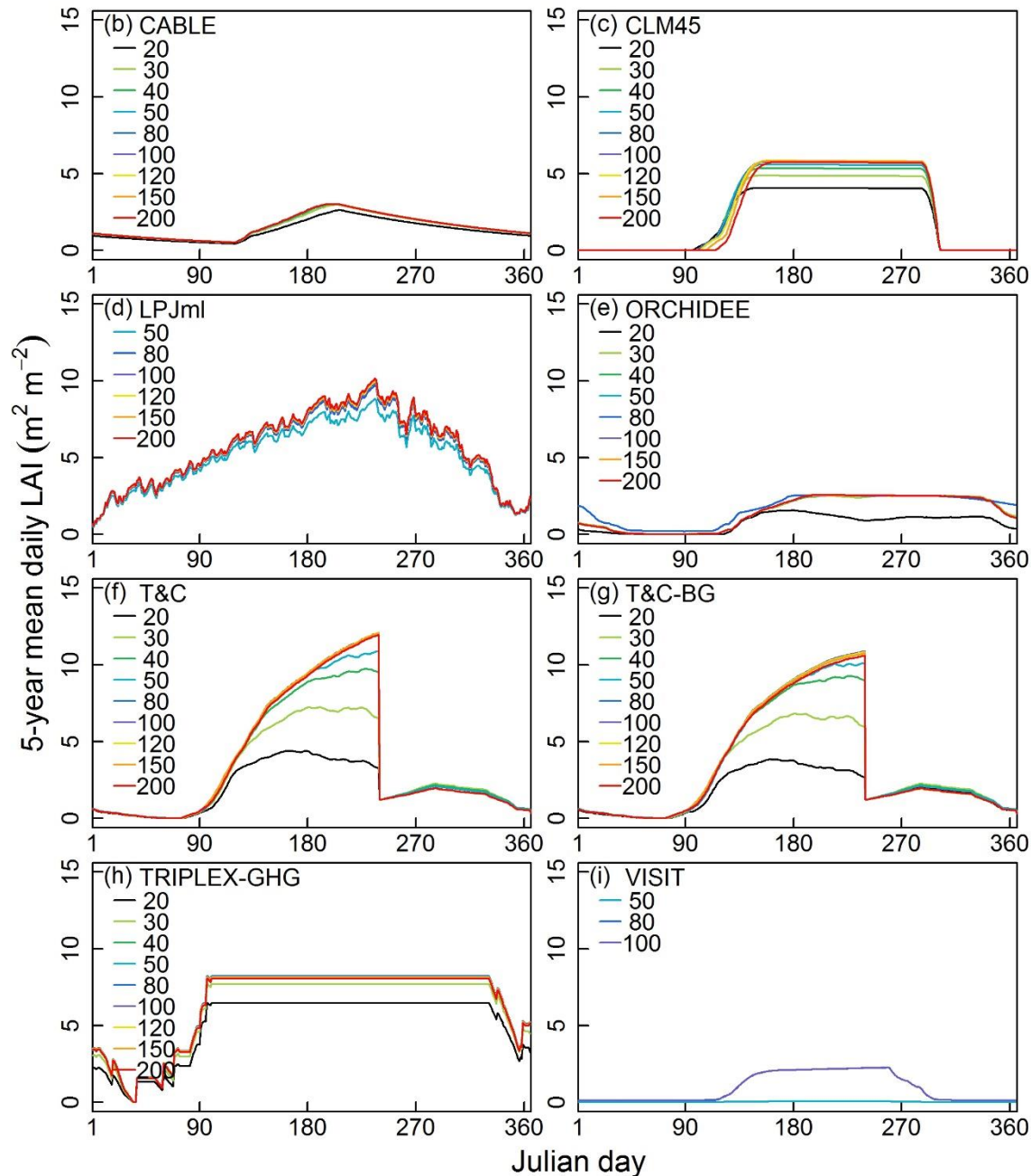
5-year mean monthly GPP



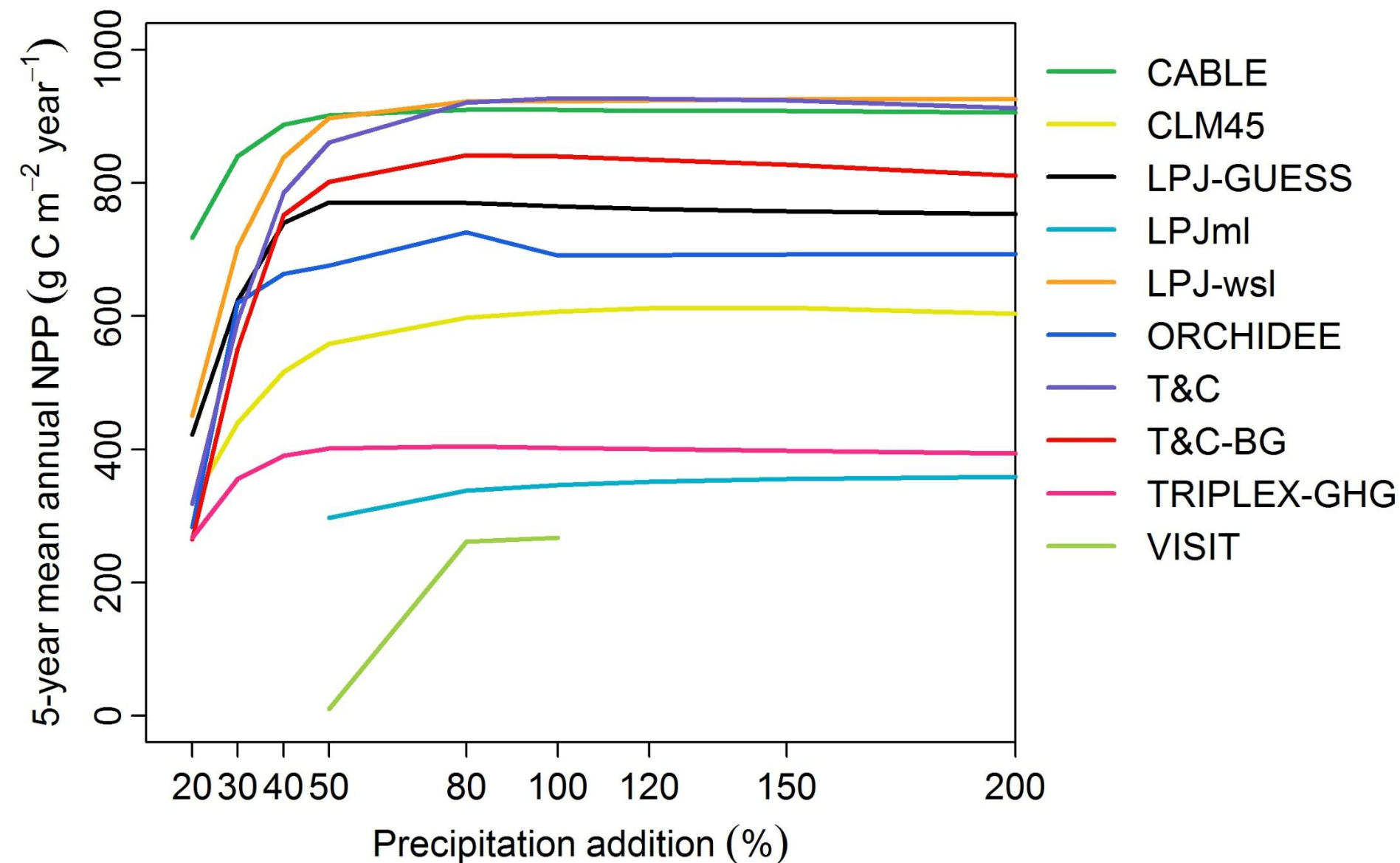
5-year mean seasonal dynamic of GPP



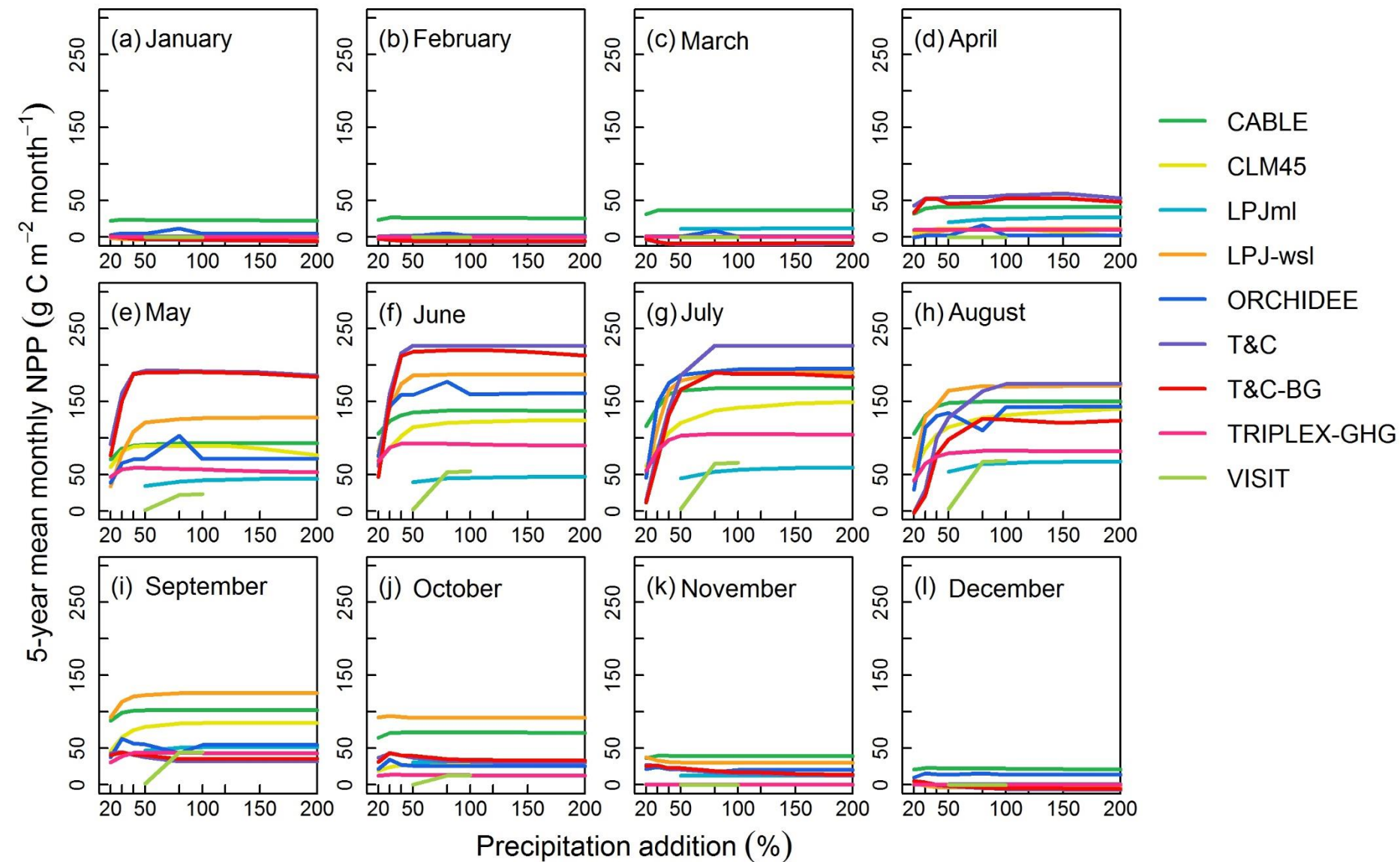
5-year mean seasonal dynamic of LAI



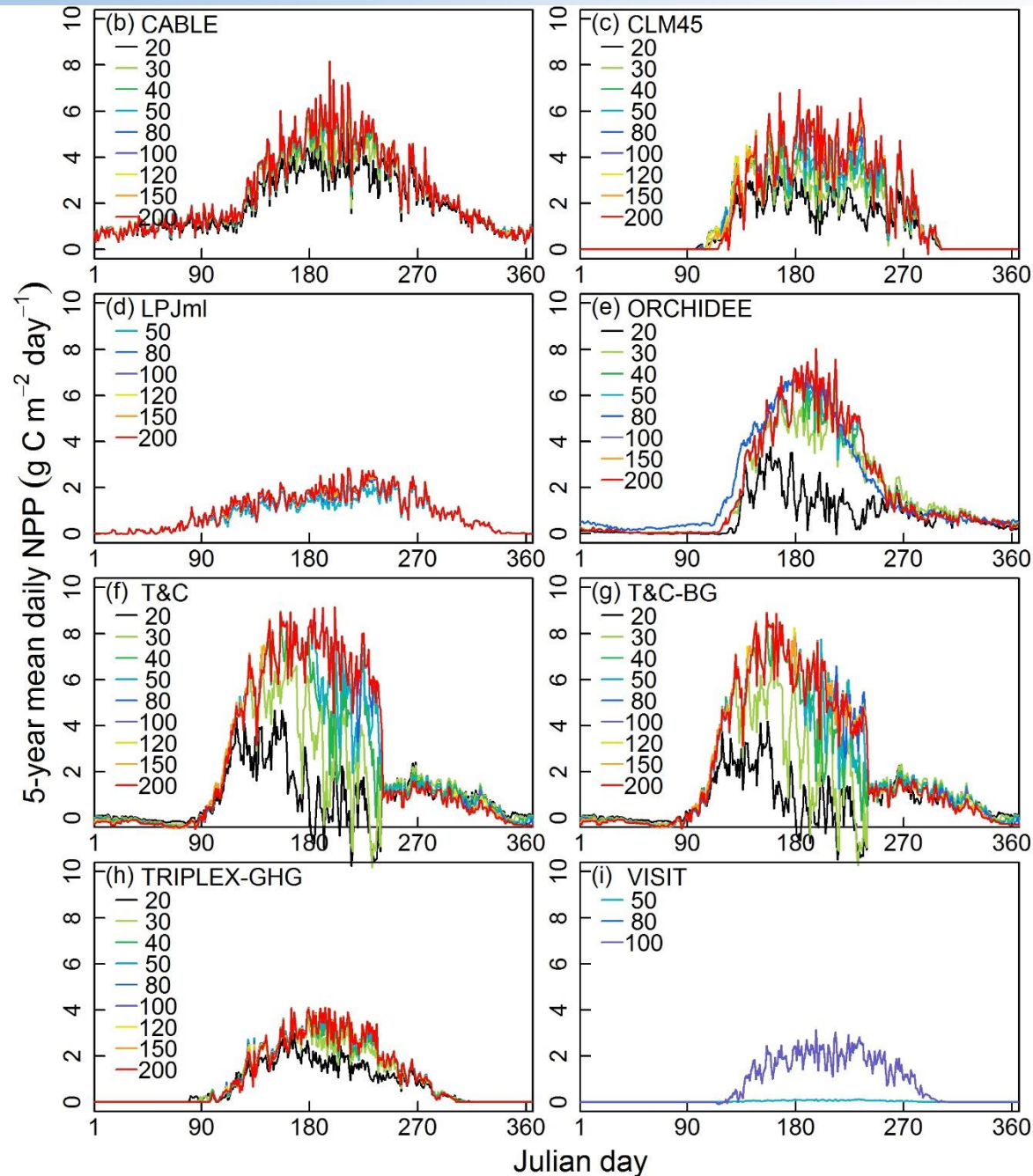
5-year mean annual NPP



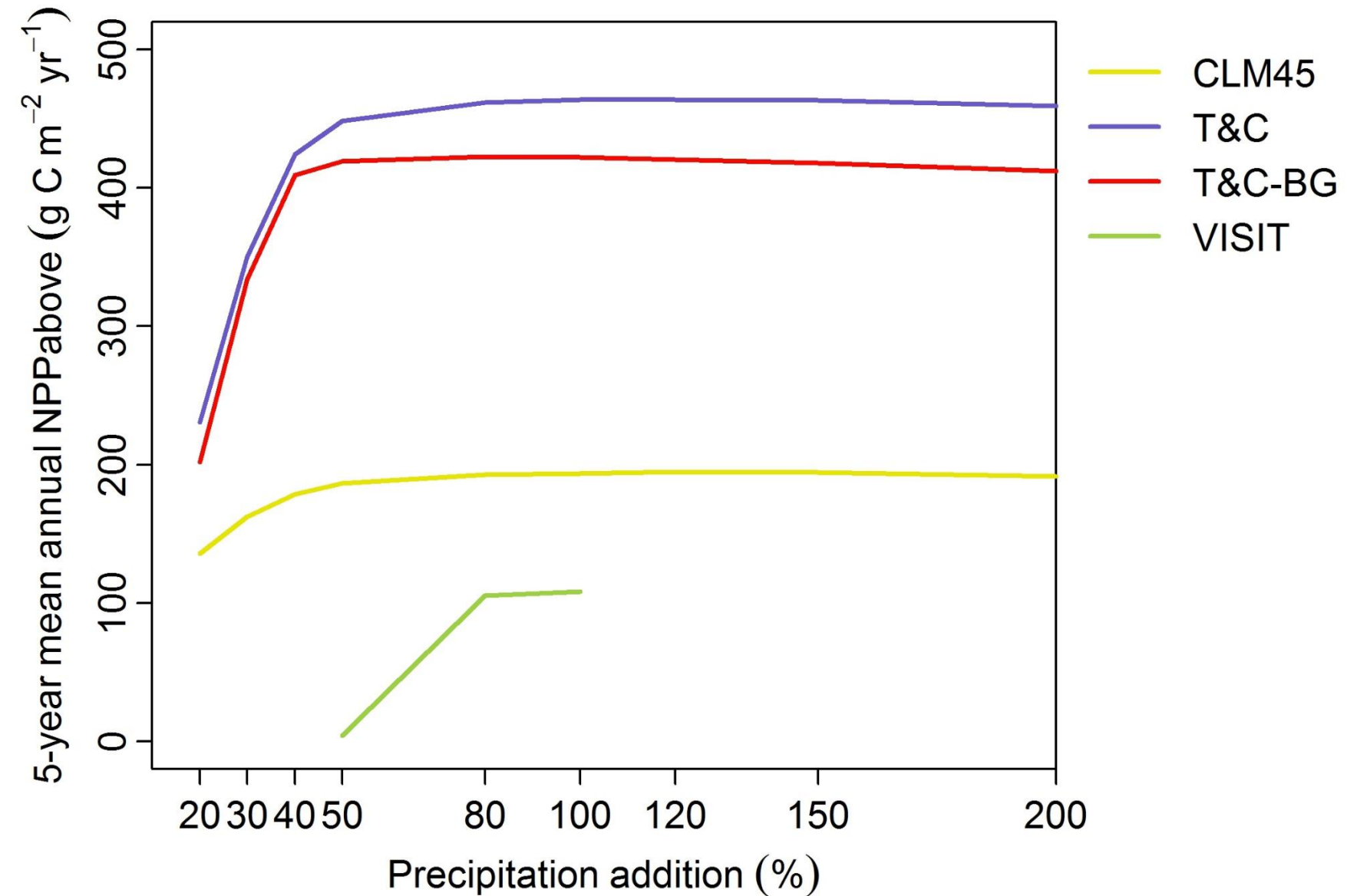
5-year mean monthly NPP



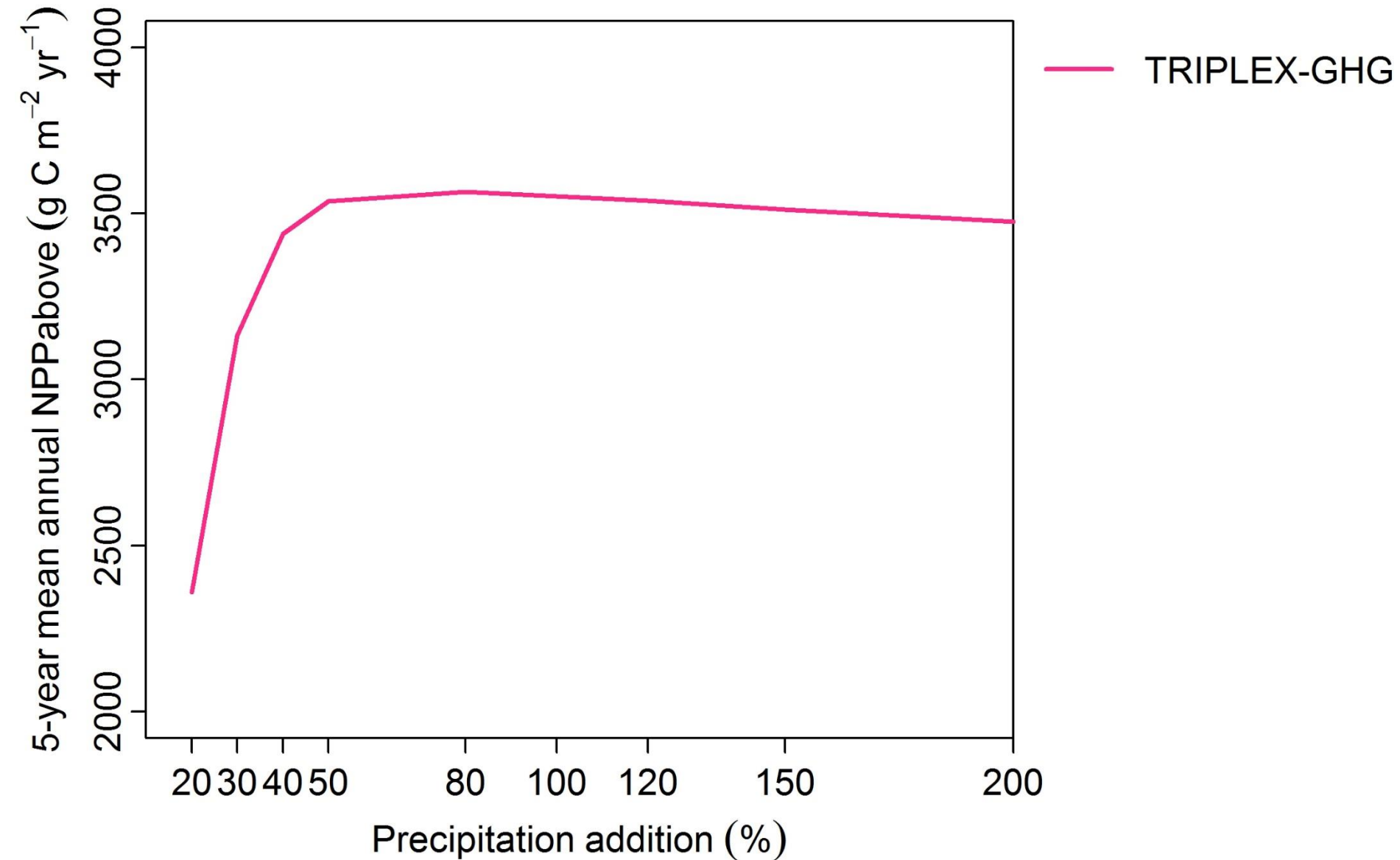
5-year mean seasonal dynamic of NPP



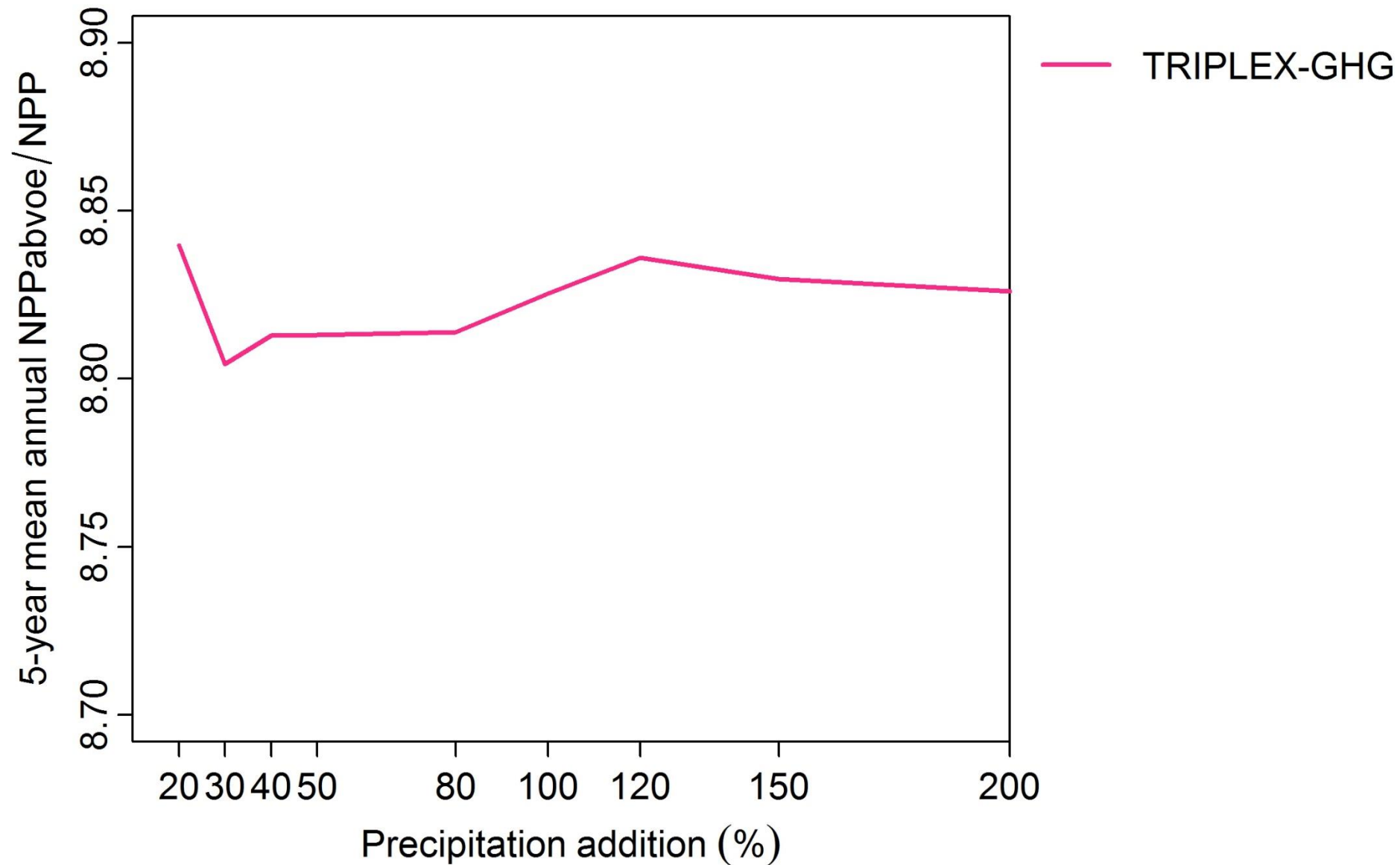
5-year mean annual aboveground NPP



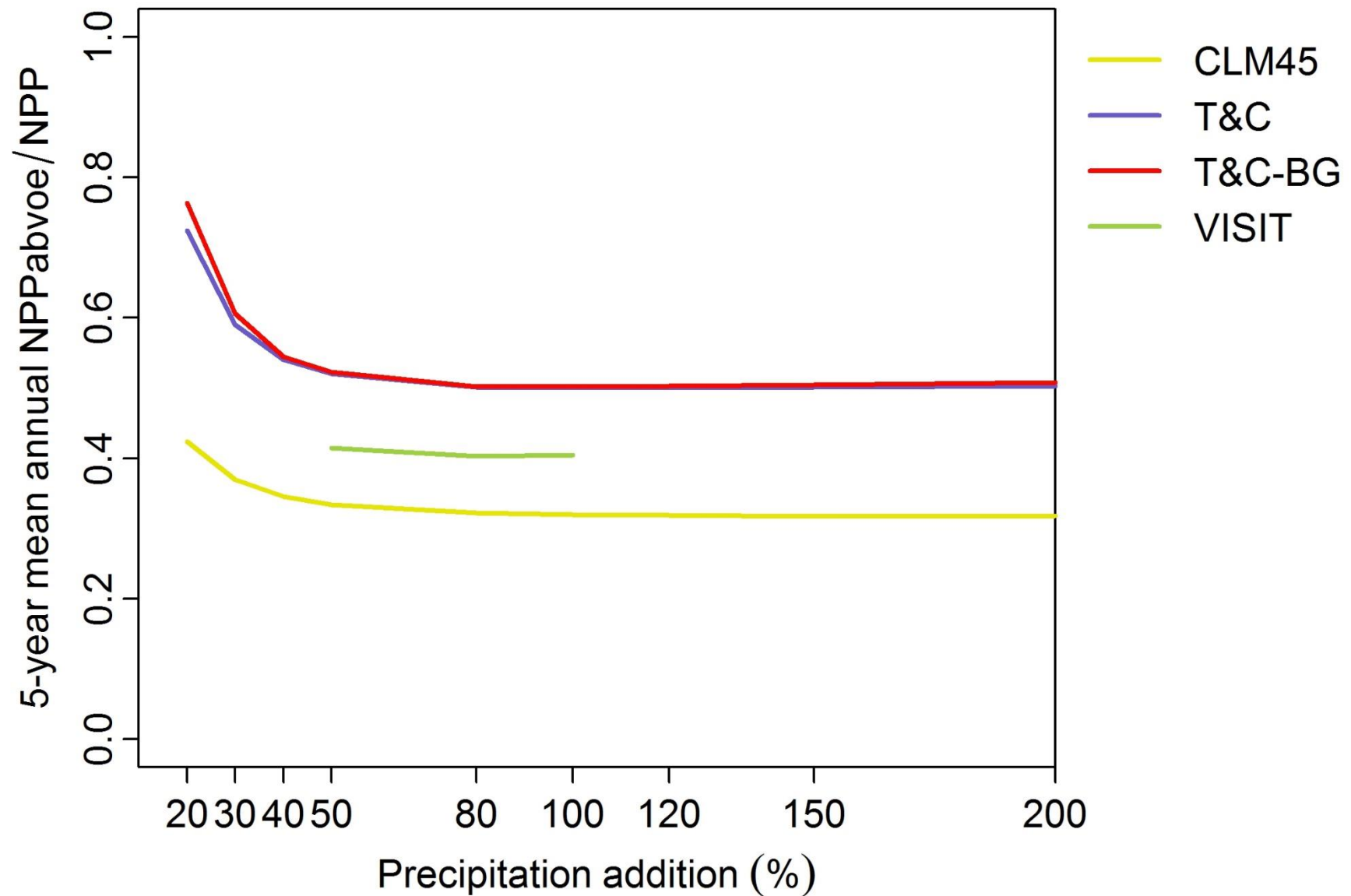
5-year mean annual aboveground NPP



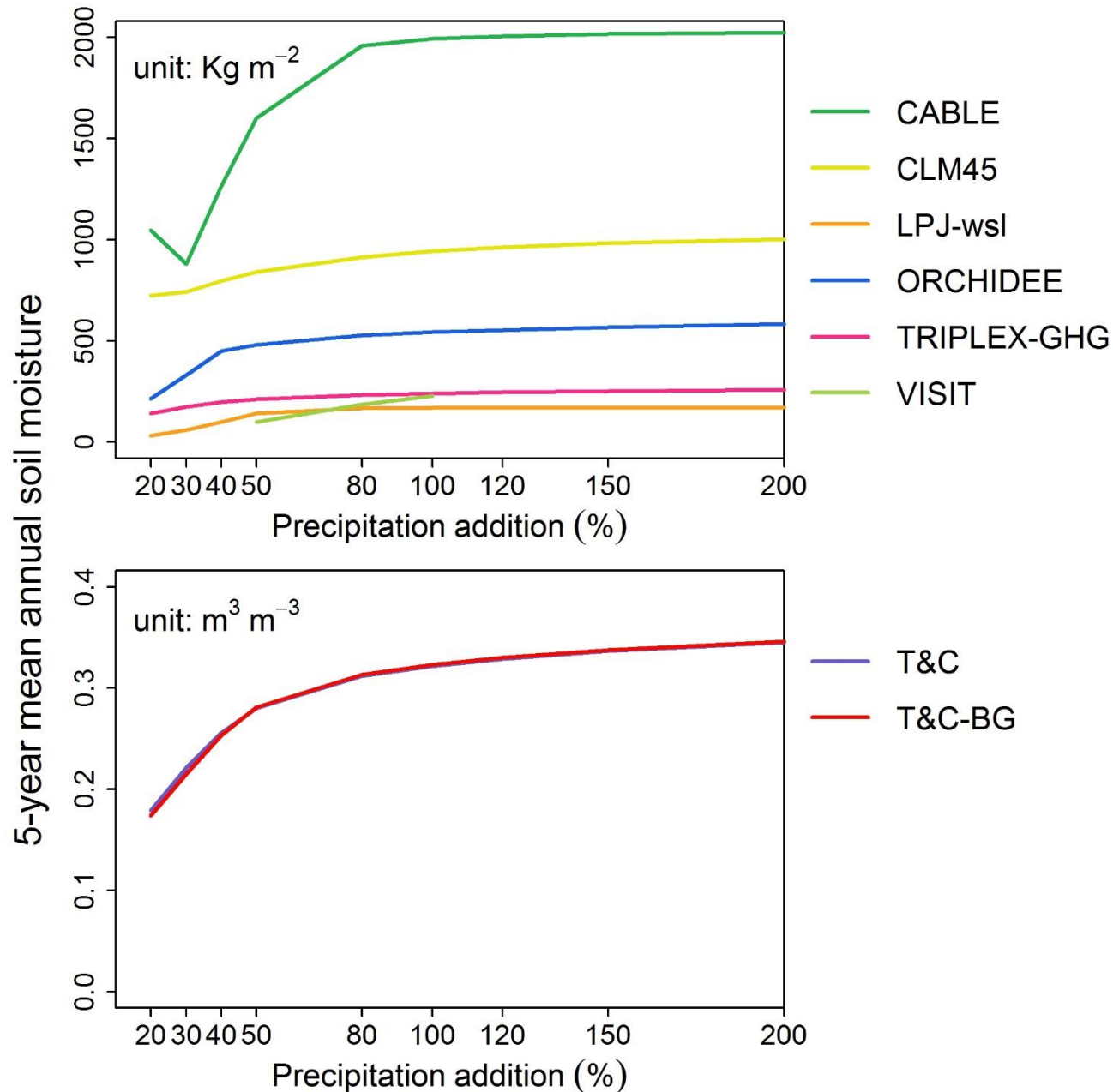
5-year mean annual NPPabove/NPP ratio



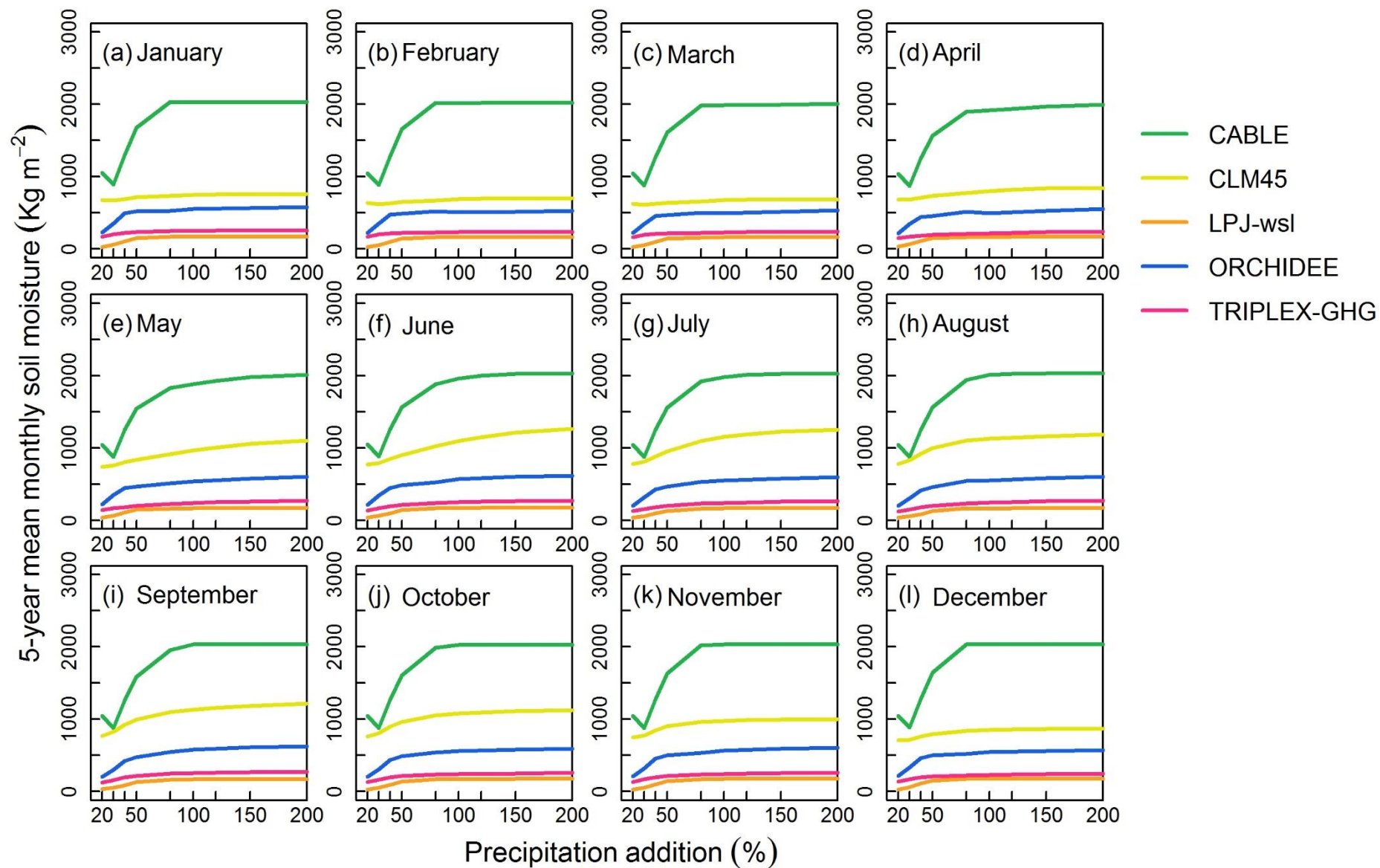
5-year mean annual NPPabove/NPP ratio



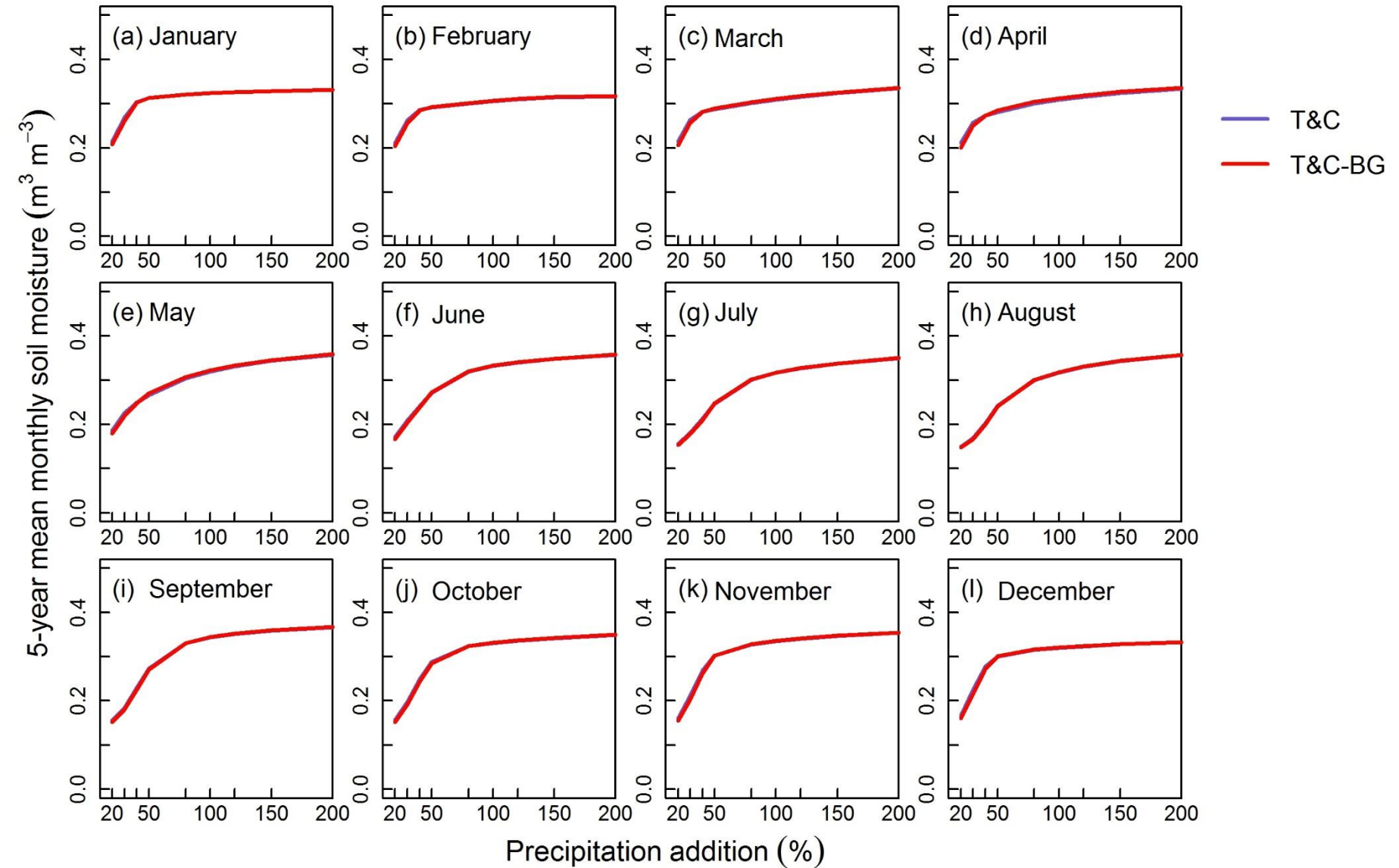
5-year mean annual total soil moisture



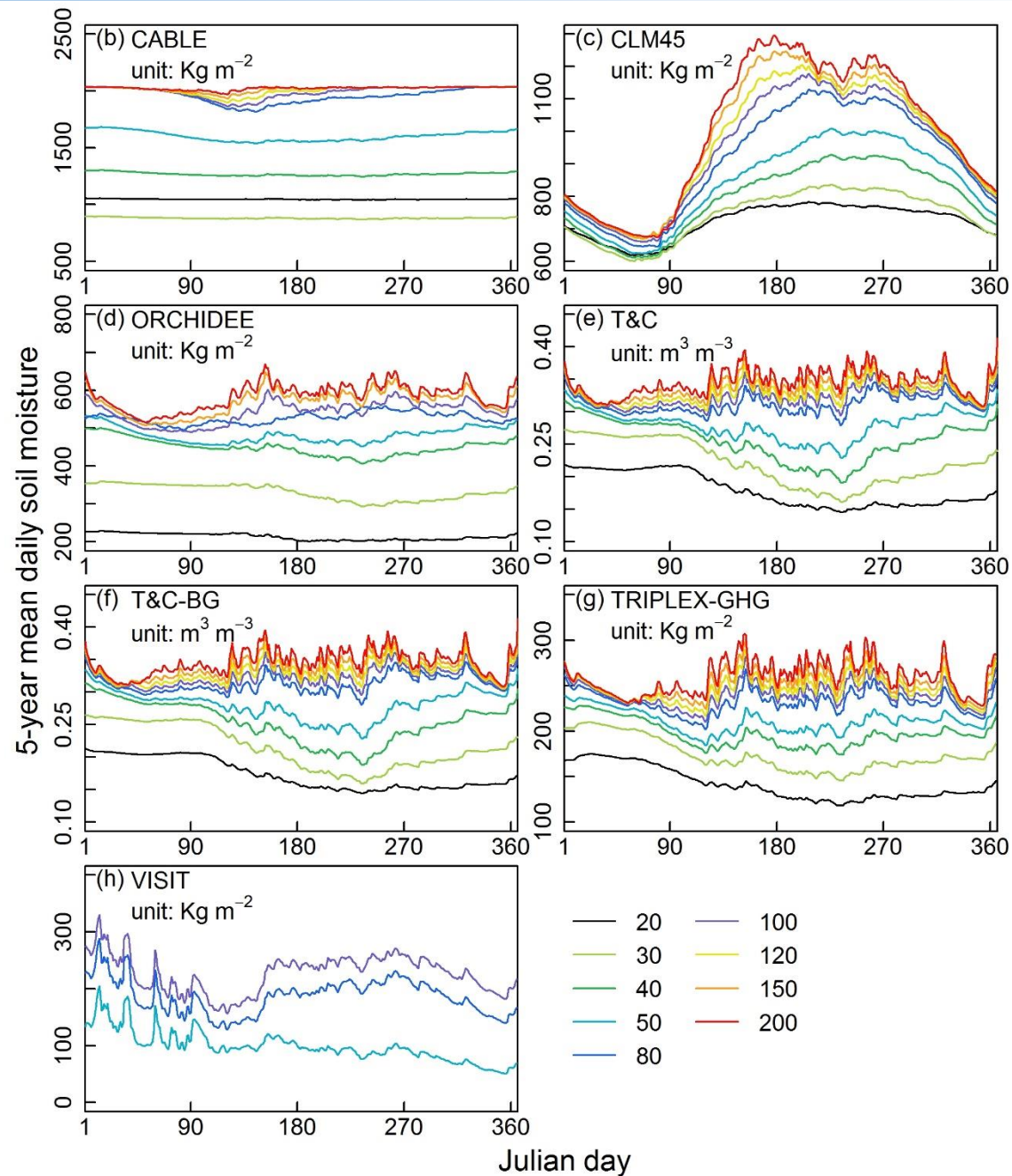
5-year mean monthly total soil moisture



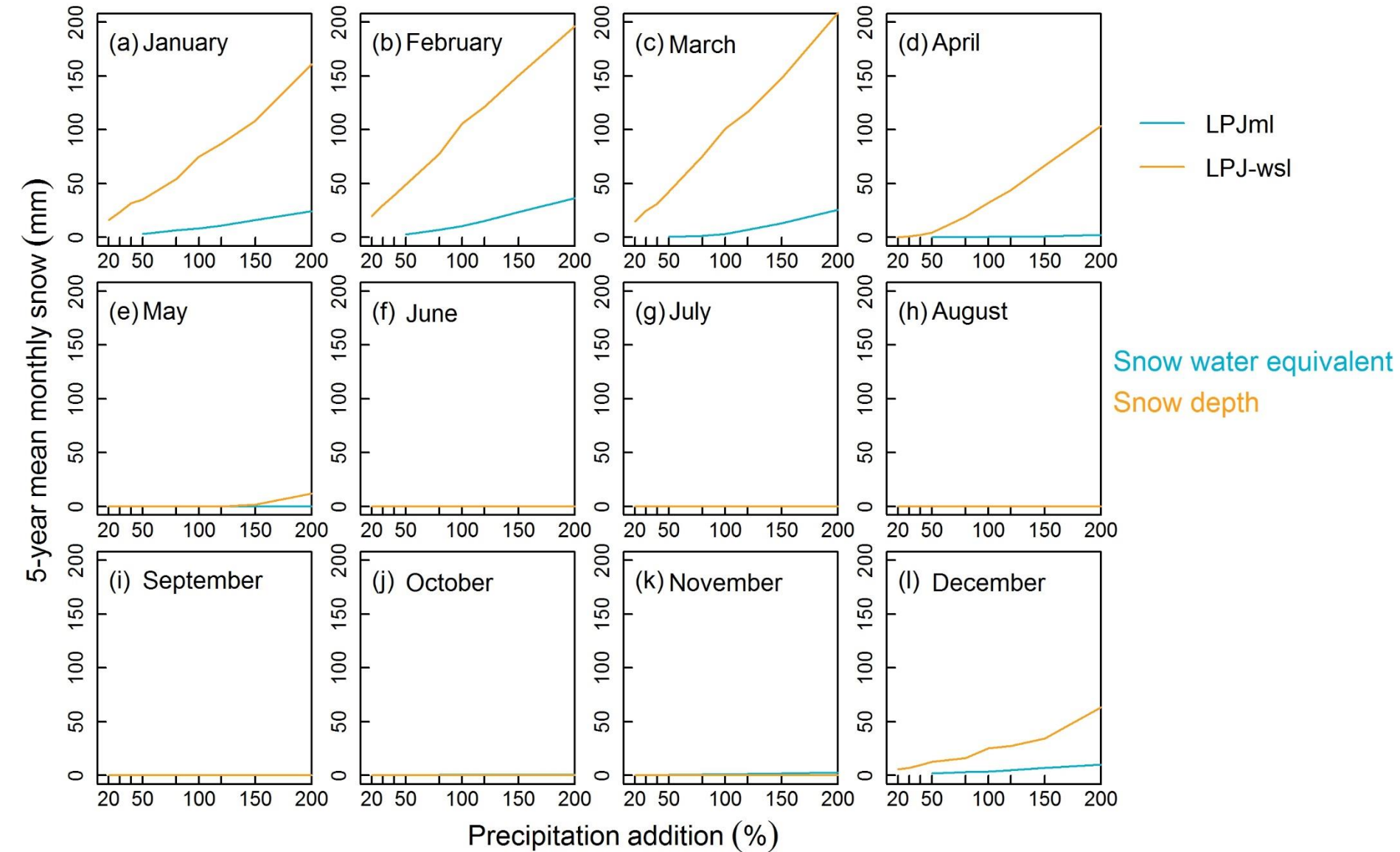
5-year mean monthly total soil moisture



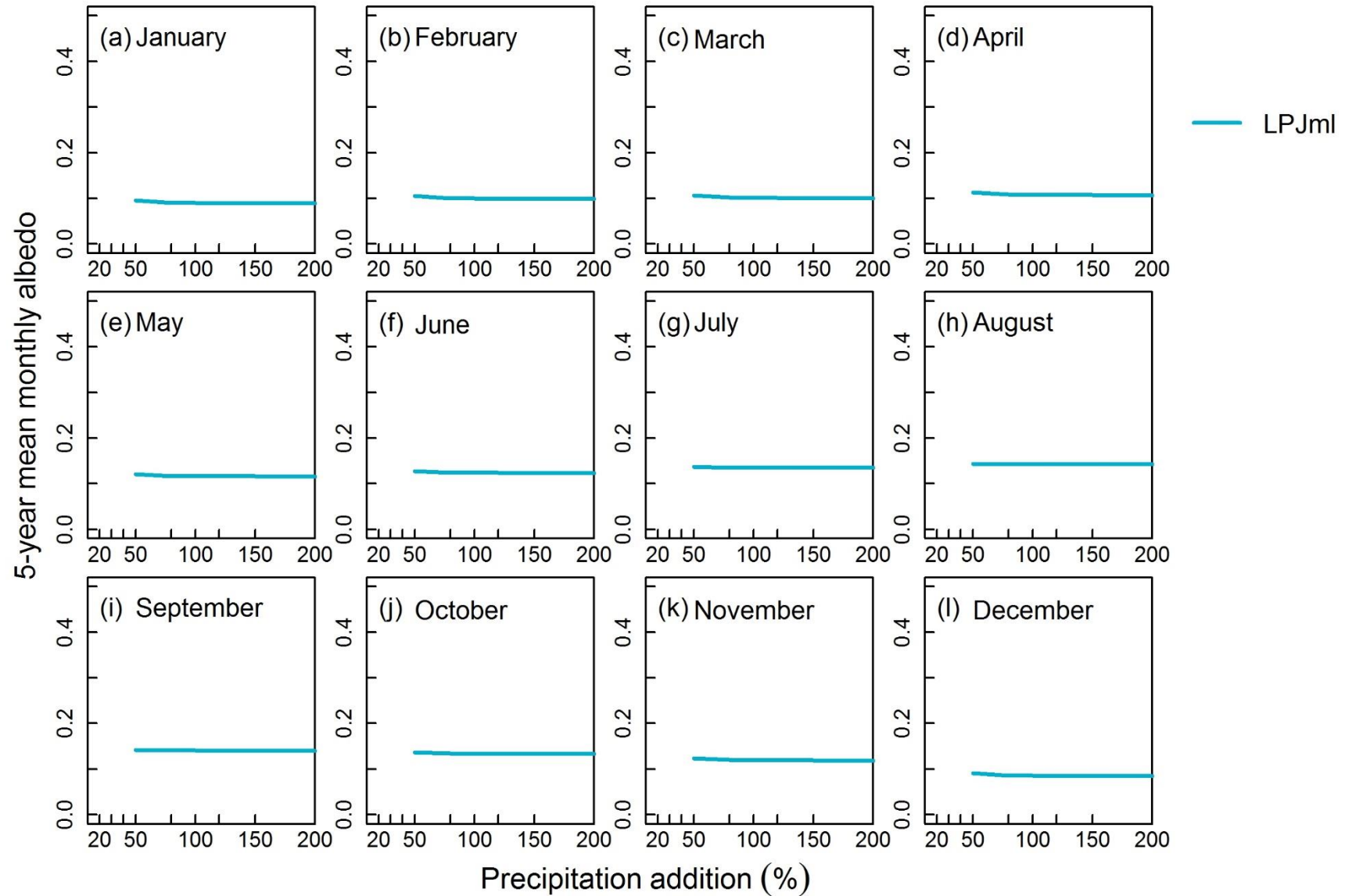
5-year mean seasonal dynamic of total soil moisture



5-year mean monthly snow depth



5-year mean monthly albedo



4 Messages

- Annual GPP and NPP show increase trend when precipitation addition is below 50% in all available models, but no response is visible over 50% of precipitation addition.
- Simulated precipitation addition increased ecosystem productivity in summer period, rather than that in spring. This indicates that precipitation addition altered ecosystem productivity via increasing plant growth in summer, rather than changing spring phenology.
- Annual ANPP/NPP ratio shows decrease trend when precipitation addition is below 50% in 3 models (T&C, T&C-BG, and TRIPLEX-GHG). Most models yet did not provide the individual components of NPP. To examine the response of NPP allocation to altered precipitation, the individual components of NPP are recommended to be produced by all models.

Thanks for your attention